Application for
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For

MANUFACTURING METHOD OF SEMICONDUCTOR DEVICE, AUTOMATIC OPERATION METHOD AND AUTOMATIC OPERATION SYSTEM OF SEMICONDUCTOR MANUFACTURING APPARATUS, AND AUTOMATIC OPERATION METHOD OF CMP APPARATUS

SPECIFICATION

TITLE OF THE INVENTION

MANUFACTURING METHOD OF SEMICONDUCTOR DEVICE, AUTOMATIC OPERATION METHOD AND AUTOMATIC OPERATION SYSTEM OF SEMICONDUCTOR MANUFACTURING APPARATUS, AND AUTOMATIC OPERATION METHOD OF CMP APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority from Japanese Paten Application No. JP2003-107658 filed on April 11, 2003, the content of which is hereby incorporated by reference into this application.

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a manufacturing method of a semiconductor device, an automatic operation method and an automatic operation system of semiconductor manufacturing apparatus, and an automatic operation method of CMP (Chemical Mechanical Polishing) apparatus. More particularly, the present invention relates to a technique effectively applied to an APC (Advanced Process Control) in the process for the high-mix low-volume manufacturing of the semiconductor devices.

BACKGROUND OF THE INVENTION

As a technique examined by the inventors of the present invention, the technique as follows can be shown. For example, since the polishing rate is unstable in the early stage of the polishing in such semiconductor manufacturing apparatus as the

CMP apparatus, the initial polishing in which the dummy wafer is used as a starting dummy is performed and after the polishing rate becomes stable, the product wafer is polished. In this manner, the stabilization of the process and the improvement of the accuracy can be achieved.

However, it is necessary in many cases to separately set the process condition (recipe) of the dummy wafer and the process condition (recipe) of the product wafer. Therefore, the process of the dummy wafer becomes a problem in the development of the automation of the instruction and control of only the process condition of the product.

The method as follows is known as the automatic operation method of such semiconductor manufacturing apparatus as the CMP apparatus. That is, the latest polishing rate is calculated based on the difference between the film thickness data before the polishing and the film thickness data after the polishing and the actual polishing time, and then, the process recipe data from the host computer of the factory is set as the optimum recipe to the CMP apparatus (e.g., Japanese Patent Application Laid-Open No. 11-186204).

In addition, the method as follows is also known. That is, the film thickness after the CMP is measured, and the subsequent etching process is performed under the condition determined in the feedforward manner based on the measured film thickness (e.g., Japanese Patent Application Laid-Open No. 2002-151465).

In addition, the method as follows is also known. That is, the visible light is irradiated to the wafer after the polishing and the film thickness of the wafer is measured by

using the optical sensor, and the measurement result is returned to the control unit to set the polishing time of the next wafer (e.g., Japanese Patent Application Laid-Open No. 8-17768).

In addition, the method as follows is also known. That is, the infrared laser beam is irradiated to the wafer during the polishing and the change in the polished film thickness is measured by the measurement of the Doppler shift of the reflected light (e.g., Japanese Patent Application Laid-Open No. 2000-35316).

In addition, the method as follows is also known. That is, a relatively flat region which is less influenced by the device pattern during the CMP is specified based on the reflected light intensity and the frequency spectrum, and the thickness of the wafer is measured with high accuracy (e.g., Japanese Patent Application Laid-Open No. 2003-42721).

In addition, the method as follows is also known. That is, the latest polishing rate of the inputted lot is calculated based on the difference between the thickness data before the polishing and the thickness data after the polishing and the actual polishing time and the polishing rate is stored as the varying parameter, and then, the recipe fixed part and the recipe varying part are combined and set as the optimum recipe to the CMP apparatus (e.g., Japanese Patent Application Laid-Open No. 11-186204).

In addition, the method as follows is also known. That is, after processing the preceding wafer by the CMP apparatus and measuring the thickness of the wafer, the polishing time of the main wafer is set based on the measurement result and the

main wafer is processed. Then, the residual film thickness is measured and calculated to determine the wafers requiring the additional polishing (e.g., Japanese Patent Application Laid-Open No. 2000-15574).

SUMMARY OF THE INVENTION

Meanwhile, as a result of the examination by the inventors of this invention about the automation method of the CMP apparatus as mentioned above, the following are shown.

For example, in the case of using the dummy wafer as a starting dummy as described above, it is necessary to separately set the process condition (recipe) for the dummy wafer and the process condition (recipe) for the product wafer, and the process of the dummy wafer becomes a problem in the development of the automation of the instruction and control of only the process condition of the product.

Furthermore, in order to realize the unmanned operation in the CMP (Chemical Mechanical Polishing) process, the work prior to the product processing must be eliminated. For its achievement, the method described in Japanese Patent Application Laid-Open No. 11-186204 is known. In the method described in Japanese Patent Application Laid-Open No. 11-186204, the devices are manufactured with high accuracy by the use of the host computer in addition to the data of the processes before and after the CMP. However, in the production line for the high-mix low-volume manufacturing with smaller lot size, when the film thickness measuring device and the polishing apparatus are located in different positions, the transport control becomes complicated. Furthermore, since it

takes time until the result of the process is obtained by the measurement, the control is delayed and the accuracy of the control is reduced. Therefore, the response to the process is insufficient in the CMP process in which the polishing ability is changed at every second.

Also, in the method described in Japanese Patent Application Laid-Open No. 2002-151465, the film thickness after the CMP is used in the control of the etching process in the feedforward manner. However, the feedback to the CMP or the feedforward to the CVD process after the CMP cannot be done.

Therefore, an object of the present invention is to provide a manufacturing method of a semiconductor device, an automatic operation method and an automatic operation system of semiconductor manufacturing apparatus, and an automatic operation method of CMP apparatus for promoting the automation of a semiconductor manufacturing process with the large ratio of manual work such as the CMP process, which makes it possible to achieve the rationalization and the manpower reduction, the improvement of the processing ability, the reduction of the investment amount, and the improvement of the indirect operation efficiency.

The above and other objects and novel characteristics of the present invention will be apparent from the description and the accompanying drawings of this specification.

The typical ones of the inventions disclosed in this application will be briefly described as follows.

More specifically, in the manufacturing method of a semiconductor device, an automatic operation method and an automatic operation system of semiconductor manufacturing

apparatus, and an automatic operation method of CMP apparatus, the dummy wafer is processed under the predetermined process condition before processing the product wafer by just downloading the process recipe (process condition) of the product wafer from the host computer to the CMP apparatus in the CMP process. In this manner, the unmanned operation can be achieved.

In addition, the measurement data of the film thickness measuring device mounted to the unmanned CMP apparatus is transmitted together with such process data as the polishing time from the CMP apparatus to the host computer. By doing so, the recipe condition of the CMP apparatus can be changed based on the latest data, and the process condition of the subsequent process is used in the feedforward manner based on the film thickness measurement data. In this manner, it is possible to eliminate the measurement process in the subsequent process.

Furthermore, in the automatic operation system of the semiconductor manufacturing apparatus according to the present invention, it is possible to change the parameters of the process recipe for each of the product wafers in the host computer from the terminal outside the clean room via the network.

More details are as follows.

(1) The manufacturing method of a semiconductor device according to the present invention comprises the steps of: transmitting a process condition of a product wafer from a host computer to a semiconductor manufacturing apparatus; automatically processing a dummy wafer in the semiconductor manufacturing apparatus in accordance with a predetermined

process condition; and processing the product wafer in the semiconductor manufacturing apparatus in accordance with the transmitted process condition of the product wafer.

(2) The manufacturing method of a semiconductor device in (1) further comprises, during or after the process of the product wafer, the steps of: measuring a thickness of a film formed on the product wafer by a film thickness measuring device mounted to the semiconductor manufacturing apparatus; transmitting the data of the measured film thickness and the process data of the semiconductor manufacturing apparatus to the host computer; and determining in the host computer the process condition of a product wafer processed later in the semiconductor manufacturing apparatus based on the transmitted film thickness data and the process data.

(3) The manufacturing method of a semiconductor device in (1) further comprises, during or after the process of the product wafer, the steps of: measuring a thickness of a film formed on the product wafer by a film thickness measuring device mounted to the semiconductor manufacturing apparatus; transmitting the data of the measured film thickness to the host computer; and determining in the host computer the process condition of the product wafer in the subsequent process based on the transmitted film thickness data.

(4) The manufacturing method of a semiconductor device in (1) further comprises the step of: determining in the host computer the process condition of the product wafer in the subsequent process based on the transmitted film thickness data.

(5) The automatic operation method of semiconductor manufacturing apparatus according to the present invention

comprises the steps of: transmitting a process condition of a product wafer from a host computer to a semiconductor manufacturing apparatus; automatically processing a dummy wafer in the semiconductor manufacturing apparatus in accordance with a predetermined process condition; and processing the product wafer in the semiconductor manufacturing apparatus in accordance with the transmitted process condition of the product wafer.

(6) The automatic operation method of semiconductor manufacturing apparatus in (5) further comprises, during or after the process of the product wafer, the steps of: measuring a thickness of a film formed on the product wafer by a film thickness measuring device mounted to the semiconductor manufacturing apparatus; transmitting the data of the measured film thickness and the process data of the semiconductor manufacturing apparatus to the host computer; and determining in the host computer the process condition of a product wafer processed later in the semiconductor manufacturing apparatus based on the transmitted film thickness data and the process data.

(7) The automatic operation method of semiconductor manufacturing apparatus in (5) further comprises, during or after the process of the product wafer, the steps of: measuring a thickness of a film formed on the product wafer by a film thickness measuring device mounted to the semiconductor manufacturing apparatus; transmitting the data of the measured film thickness to the host computer; and determining in the host computer the process condition of the product wafer in the subsequent process based on the transmitted film thickness data.

(8) The automatic operation method of semiconductor manufacturing apparatus in (6) further comprises the step of: determining in the host computer the process condition of the product wafer in the subsequent process based on the transmitted film thickness data.

(9) The automatic operation method of CMP (Chemical Mechanical Polishing) apparatus according to the present invention comprises the steps of: transmitting a process condition of a product wafer from a host computer to a CMP apparatus; automatically processing a dummy wafer in the CMP apparatus in accordance with a predetermined process condition; and processing the product wafer in the CMP apparatus in accordance with the transmitted process condition of the product wafer.

(10) The automatic operation method of CMP apparatus in (9) further comprises, during or after the process of the product wafer, the steps of: measuring a thickness of a film formed on the product wafer by a film thickness measuring device mounted to the CMP apparatus; transmitting the data of the measured film thickness and the process data of the CMP apparatus to the host computer; and determining in the host computer a polishing time of the product wafer processed later in the CMP apparatus based on the transmitted film thickness data and process data.

(11) The automatic operation method of CMP apparatus in (9) further comprises, during or after the process of the product wafer, the steps of: measuring a thickness of a film formed on the product wafer by a film thickness measuring device mounted to the CMP apparatus; transmitting the data of

the measured film thickness to the host computer; and determining in the host computer the process condition of the product wafer in the subsequent process based on the transmitted film thickness data.

(12) The automatic operation method of CMP apparatus in (10) further comprises the step of: determining in the host computer the process condition of the product wafer in the subsequent process based on the transmitted film thickness data.

(13) The automatic operation system of semiconductor manufacturing apparatus comprises: a host computer to store a process condition of a product wafer; and an apparatus control unit to control the semiconductor manufacturing apparatus, wherein the apparatus control unit automatically processes a dummy wafer (dummy wafer on which a film to be polished is formed in a preliminary process) in the semiconductor manufacturing apparatus in accordance with a predetermined process condition when the process condition of the product wafer is transmitted from the host computer to the semiconductor manufacturing apparatus, and the apparatus control unit processes the product wafer in the semiconductor manufacturing apparatus in accordance with the transmitted process condition of the product wafer.

(14) In the automatic operation system of semiconductor manufacturing apparatus in (13), during or after the process of the product wafer, the apparatus control unit measures a thickness of a film formed on the product wafer by a film thickness measuring device mounted to the semiconductor manufacturing apparatus and also transmits the measured thickness data and the process data of the semiconductor

manufacturing apparatus to the host computer, and the host computer determines the process condition of a product wafer processed later in the semiconductor manufacturing apparatus based on the transmitted film thickness data and process data.

(15) In the automatic operation system of semiconductor manufacturing apparatus in (13), during or after the process of the product wafer, the apparatus control unit measures a thickness of a film formed on the product wafer by a film thickness measuring device mounted to the semiconductor manufacturing apparatus and also transmits the measured thickness data to the host computer, and the host computer determines the process condition of the product wafer in the subsequent process based on the transmitted film thickness data.

(16) In the automatic operation system of semiconductor manufacturing apparatus in (13), the host computer and the apparatus control unit are connected via a network, and the process condition of the product wafer in the host computer can be changed from the terminal connected to the network and provided outside the clean room.

(17) In the automatic operation method of CMP apparatus in (9), the CMP apparatus has a shelf-management function by which a plurality of the dummy wafers stored in the CMP apparatus are sequentially processed and also a utilization management function by which the dummy wafers are replaced when they are processed predetermined times.

As described above, according to the manufacturing method of a semiconductor device, the automatic operation method and the automatic operation system of semiconductor manufacturing apparatus, and the automatic operation method of CMP apparatus,

the waiting time of the operator can be reduced, the rationalization and the manpower reduction can be achieved, the processing ability can be improved, the investment amount can be reduced, the indirect operation efficiency can be improved, the thickness accuracy of the wiring interlayer film can be improved, and the manufacturing yield can be improved.

BRIEF DESCRIPTIONS OF THE DRAWINGS

FIG. 1 is an explanatory diagram showing the configuration of the automatic operation system and the automatic operation method of the semiconductor manufacturing apparatus according to an embodiment of the present invention;

FIG. 2 is an explanatory diagram showing the process flow of the CMP apparatus according an embodiment of the present invention;

FIG. 3A is a sectional view showing the STI structure according an embodiment of the present invention;

FIG. 3B is an explanatory diagram showing the process flow of the STI according to an embodiment of the present invention;

FIG. 4A is a sectional view showing the ILD structure according to an embodiment of the present invention;

FIG. 4B is an explanatory diagram showing the process flow of the ILD according to an embodiment of the present invention;

FIG. 5A is a sectional view showing the IMD structure according to an embodiment of the present invention;

FIG. 5B is an explanatory diagram showing the process flow of the IMD in an embodiment of the present invention; and

FIG. 6 is a flow chart showing an example of the manufacturing method of the semiconductor device according to an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, an embodiment of the present invention will be described in detail with reference to the accompanying drawings. Note that components having the same function are denoted by the same reference symbols throughout the drawings for describing the embodiment, and the repetitive description thereof is omitted.

FIG. 1 is an explanatory diagram showing the configuration of the automatic operation system and the automatic operation method of the semiconductor manufacturing apparatus according to this embodiment of the present invention, FIG. 2 is an explanatory diagram showing the process flow of the CMP apparatus according to this embodiment, FIG. 3A is a sectional view showing the STI structure according to this embodiment, FIG. 3A is an explanatory diagram showing the process flow of the STI according to this embodiment, FIG. 4A is a sectional view showing the ILD structure according to this embodiment, FIG. 4B is an explanatory diagram showing the process flow of the ILD according to this embodiment, FIG. 5A is a sectional view showing the IMD structure according to this embodiment, FIG. 5B is an explanatory diagram showing the process flow of the IMD in this embodiment, and FIG. 6 is a flow chart showing an example of the manufacturing method of the semiconductor device according to this embodiment.

First, an example of the configuration of the automatic

operation system and the automatic operation method of the semiconductor manufacturing apparatus according to this embodiment will be described with reference to FIG. 1. The semiconductor manufacturing apparatus in this embodiment is, for example, CMP apparatus 11 and is comprised of an apparatus control unit 12 to control the CMP apparatus 11, a load port formed of a dummy wafer port 13 and a product wafer port 14, a polishing section 15 to polish a wafer, a cleaning section 16 to clean the wafer, and a film thickness measuring device 17 to measure the thickness of a film formed on the wafer. The semiconductor manufacturing apparatus is placed in a clean room. The CMP apparatus 11 is connected to a host computer 19 via the network 18 in the clean room.

The host computer 19 manages the semiconductor manufacturing process and contains data such as the process recipe 24 of the product wafer and the parameter 25 for each product and process. In the host computer 19, the polishing time PT (I) of the product wafer in the CMP apparatus 11 is calculated based on the parameter 25 for each product and process. The calculated polishing time PT (I) is incorporated in the process recipe 24 of the product wafer. Then, the process recipe 24 of the product wafer is downloaded from the host computer 19 to the CMP apparatus 11. In this manner, the CMP apparatus 11 is automatically operated.

A terminal 20 and the like are connected to the network 18 in the clean room, and terminals 22 and 23 and the like are connected to the network 21 outside the clean room. The network 18 in the clean room and the network 21 outside the clean room are connected to each other. The data stored in the host

computer 19 or the CMP apparatus 11 can be browsed and edited from the terminals 20, 22, and 23.

In the CMP process of the dummy wafer in the CMP apparatus 11, as shown by the arrows in FIG. 1, the dummy wafer is transferred from the dummy wafer port 13 to the polishing section 15 and the dummy wafer is polished in the polishing section 15. Thereafter, the dummy wafer is transferred to the cleaning section 16 and cleaned in the cleaning section 16, and then, the dummy wafer is stored in the dummy wafer port 13. A film to be polished is formed on the dummy wafer used here in the preliminary process so as to enhance the function as the initial dummy. For example, in the case where a metal film on the product wafer is to be polished, a metal film or an oxide film (SiO_2 film or the like) is formed on the dummy wafer, and alternatively, in the case where an insulator is to be polished, an oxide film (SiO_2 film or the like) is formed on the dummy wafer in the preliminary process. Subsequently, in the CMP process of the product wafer, the product wafer is transferred from the product wafer port 14 to the polishing section 15, and the product wafer is polished in the polishing section 15. Thereafter, the product wafer is transferred to the cleaning section 16 and cleaned in the cleaning section 16. Then, after the product wafer is transferred to the film thickness measuring device 17 and the thickness of the film formed on the product wafer is measured in the film thickness measuring device 17, the product wafer is stored in the product wafer port 14. The data of the measured film thickness and the process data of the CMP apparatus are transmitted as the complete data 26 from the CMP apparatus 11 to the host computer

19.

Next, an example of the manufacturing method of the semiconductor device including the above-mentioned CMP process steps and the automatic operation method of the semiconductor manufacturing apparatus according to this embodiment will be described with reference to FIGs. 2 to 6. The manufacturing method of the semiconductor device and the automatic operation method of the semiconductor manufacturing apparatus according to this embodiment include the process steps as follows in the CMP process.

As shown in FIG. 2, the process recipe (process condition) 27 of the dummy wafer is stored in advance in the CMP apparatus 11, and when the process recipe 24 of the product wafer is downloaded from the host computer 19 to the CMP apparatus 11, the dummy wafer 28 is automatically processed in accordance with the predetermined process condition. The non-product wafer is CMP processed as the starting dummy or the initial dummy in the wafer processing unit 29 comprised of the polishing section 15 and the cleaning section 16. After the CMP process, the dummy wafer 28 is stored in the wafer storing section 30. When the process recipe 24 of the process wafer is downloaded from the host computer 19 to the CMP apparatus 11, the dummy wafer 28 is automatically processed. By doing so, the automation of the semiconductor manufacturing process is facilitated.

The dummy wafer 28 occupies one load port or is stored in a buffer slot for holding the dummy wafer 28 in the CMP apparatus 11. The apparatus control unit 12 in the CMP apparatus 11 processes a number of wafers determined by the

process recipe 27 of the dummy wafer and has a shelf-management function by which the dummy wafers 28 are sequentially processed so that they are used evenly. In addition, the apparatus control unit 12 in the CMP apparatus 11 manages the number of uses and the accumulated amount of use of the dummy wafers 28 and sends the alarm when they reach the predetermined value (time, number of uses, and the like). When the overused dummy wafer is stored in the carrier, the request to unload the dummy wafer is sent to the host computer 19, and then, the overused dummy wafer is automatically unloaded.

After the process of the dummy wafer 28, the product wafer 31 is CMP processed in the wafer processing unit 29 in accordance with the process recipe 24 of the product wafer downloaded from the host computer 19.

The thickness of the film formed on the product wafer 31 is measured at least once during or after the polishing/cleaning of the product wafer 31 by the film thickness measuring device 17 mounted to the CMP apparatus 11. Although it is also possible to measure the film thickness before the polishing, the polishing rate can be calculated based on the thickness before the polishing and that after the thickness when the film thickness is already measured in the preliminary process. Therefore, it is not so necessary to measure the film thickness before the polishing.

Then, after the finish of the CMP process of the product wafer 31, the complete data 26 including process data such as the operating time of the polishing head and the polishing pad, the polishing time, the polishing pressure, the revolutions, and the slurry amount and the film thickness measurement data

is transmitted from the CMP apparatus 11 to the host computer 19.

Then, process conditions such as the polishing time of the product wafer processed next are determined by the host computer 19 based on the film thickness measurement data and the process data transmitted from the CMP apparatus 11 and the parameters for each of the polishing layers of the product wafer.

In this manner, since the latest data of the process conditions can be updated in real time, the feedback in real time becomes possible. As a method for feeding back the latest data to the lot processed next, for example, the polishing time PT (I) is determined based on the equation below.

Polishing time PT (I) = f (thickness before the polishing (I), thickness before the polishing (I-1), thickness after the polishing (I-1), thickness after the polishing (I-1), operating time of the polishing pad, the parameters for each product and process).

Also, the polishing rate RR is determined based on the equation below.

Polishing rate RR (I-1) = (thickness before the polishing (I-1) - thickness after the polishing (I-1)) / thickness after the polishing (I-1). Note that I in the equation above is a natural number representing the process number.

The polishing time PT (I) is calculated for each of the polishing heads and is downloaded to the CMP apparatus 11. In this calculation, the thickness measurement data in the insulator CVD (Chemical Vapor Deposition) and the like is used as the thickness before the polishing (I). The thickness data

measured for each of the wafers by the film thickness measuring device mounted to the CVD apparatus is desired also in the CVD process in the preliminary process. However, the measured value of the one or more wafers in the lot is also acceptable.

Furthermore, the host computer 19 determines the process conditions in the subsequent processes (etching, CVD, and the like) of the product wafer 31 in the feedforward manner based on the film thickness data transmitted from the CMP apparatus 11. By doing so, the film thickness measurement process in the preliminary process of the next process is omitted.

For example, in the STI (Shallow Trench Isolation) process for isolating the devices as shown in FIG. 3A, in the case where the etching of a nitride film 35 is performed after patterning the nitride film 35 formed on a silicon substrate 40, burying an oxide film 36, and performing the CMP polishing, the thickness measurement data 32 after the CMP polishing measured in the CMP apparatus 11 is used to determine the process recipe (process condition) in the next etching process in the feedforward manner (FIG. 3B). In this case, since the film thickness measurement process between the CMP process and the etching process can be eliminated, the automation can be realized more easily. Also, since all of the wafers are measured, the process condition is determined for each of the wafers, and thus, the control with higher accuracy can be achieved.

In addition, in the planarizing process of an interlayer film ILD (Interlevel Dielectric) between the MOS (Metal Oxide Semiconductor) and the first metal wiring after forming the MOS as shown in FIG. 4B, in the case where an oxide film 45 is

formed by the CVD cap after forming an oxide film 43, polycrystalline silicon 42, source and drain 46, and an oxide film 37 on the silicon substrate 41 and performing the CMP polishing, the film thickness measurement data 33 after the CMP polishing transmitted from the CMP apparatus 11 is used to determine the process condition of the next insulator CVD cap process in the feedforward manner (FIG. 4B). Since the film thickness measurement process is not necessary between the CMP process and the insulator CVD cap process, the automation can be realized more easily. Also, since all of the wafers are measured, the process condition is determined for each of the wafers, and thus, the control with higher accuracy can be achieved.

Also, in the planarizing process of the metal interlayer film IMD (Inter Metal Dielectric) after forming the metal wiring as shown in FIG. 5A, in the case where an oxide film 39 is formed by the CVD cap after forming an oxide film 44, tungsten 49 (plug), a barrier layer 48 (Ti + TiN), aluminum 50, a barrier layer 47 (Ti + TiN), and an oxide film 38 on the silicon substrate and performing the CMP polishing, the film thickness measurement data 34 after the polishing transmitted from the CMP apparatus is used to determine the process condition of the next insulator CVD cap process in the feedforward manner (FIG. 5B). Since the additional film thickness measurement process is not necessary between the CMP process and the insulator CVD cap process, the automation can be realized more easily. Also, since all of the wafers are measured, the process condition is determined for each of the wafers, and thus, the control with higher accuracy can be

achieved.

Since the parameters of the feedback and the feedforward mentioned above can be edited and checked at the terminals 22 and 23 placed outside the clean room, the indirect operation can be made more efficient and the accuracy of the control can be dramatically improved. The terminals 22 and 23 for the editing and checking operations outside the clean room are connected to the host computer or the core network the same as or different from the CMP apparatus. Therefore, it is possible to share the process load of the network, and thus, the process with higher response can be achieved.

Next, an example of the manufacturing method of a semiconductor device including the above-mentioned CMP process will be described with reference to FIG. 6. For example, the semiconductor device manufactured by this manufacturing method has an n channel MISFET on the main surface of a wafer.

After forming the n channel MISFET, an interlayer insulator is formed by depositing a silicon oxide film by the CVD on the wafer (Step S61). Subsequently, the surface of this interlayer insulator is planarized by the polishing of the CMP method (Step S62).

Next, connection holes are formed in the interlayer insulator in the n semiconductor region on the main surface of the wafer by the etching with using a photoresist film patterned by the photolithography technique as a mask (Step S63).

Next, a barrier conductor film such as titanium nitride is deposited on the wafer by the sputtering, and then, a conductive film such as tungsten is deposited on the barrier

conductor film by the CVD (Step S64).

Next, the barrier conductor film and the conductive film on the interlayer insulator are removed by the CMP to leave the barrier conductor film and the conductive film in the connection holes. By doing so, the plugs formed of the barrier conductor film and the conductive film are formed (Step S65).

Next, a Ti (titanium) film, an Al alloy film, and a titanium nitride film are sequentially deposited on the wafer in this order from below. By doing so, the conductor film is formed (Step S66).

Next, the conductive film is etched with using a photoresist film patterned by the photolithography technique as a mask. By doing so, the wiring formed of the conductive film is formed, and the manufacture of the semiconductor device is completed (Step S67).

In the foregoing, the invention made by the inventors of the present invention has been concretely described based on the embodiment. However, it is needless to say that the present invention is not limited to the foregoing embodiment and various modifications and alterations can be made within the scope of the present invention.

For example, the case where the present invention is applied to the CMP apparatus has been described in the above-mentioned embodiment. However, the present invention is not limited to this and can also be applied to other semiconductor manufacturing apparatus such as the sputtering apparatus and the CVD apparatus. For example, since initial dummy process is required in the sputtering apparatus for the stabilization of the surface state of the target, the method of dummy process in

the above-described embodiment is applicable. Also, in the CVD apparatus requiring the film thickness measurement, the method according to the present invention can be applied by providing the film thickness measuring device of the above-mentioned embodiment in the apparatus and using the measured data in the feedforward manner for the next CMP process.

The effect obtained by the typical ones of the inventions disclosed in this application will be briefly described as follows.

(1) In the CMP process in which the ratio of manual work such as the maintenance is large, the manpower reduction and the rationalization can be achieved by the automation of the CMP process.

(2) By minimizing the operator waiting time, the operation rate of the apparatus is increased to the maximum. Therefore, it is possible to improve the processing capacity and also reduce the investment amount.

(3) It is possible to optimize the conditions of the process recipe from the outside of the clean room, and the indirect operation efficiency is improved.

(4) The accuracy of the film thickness of the interlayer wiring insulator is improved and the manufacturing yield is improved.